The NASA SCI Files™
The Case of the
Radical Ride

Segment 2

As Bianca and Kali wait outside the auditorium for Dr. D and the other tree house detectives, they receive Tony's report. He has just finished his visit with Janet Goings at General Motors (GM) in Detroit, Michigan where she explained the importance of research. Ms. Goings also showed Tony some cool concept cars and explained the new fascinating technology of the fuel cell. Back in the van, the tree house detectives are beginning to worry that they won't make the awards ceremony. It looks as if there is no end to the traffic jam. To make good use of their downtime, Dr. D describes his research and model building experiences when he worked on his hovercraft. The detectives decide to email R.J. to ask him to talk to Sam James and check out the model shop at NASA Langley Research Center in Hampton, Virginia. Realizing that the next step is to test the model, the detectives join a videoconference hosted by Mike Logan with students from Cooper Elementary Magnet School in Hampton, Virginia and King's Cross Education Action Zone in London, England. The students are involved in a mousetrap car competition, and they have just finished the testing phase of the engineering design process.

Objectives

Students will

- conduct research to make informed decisions.
- understand how a fuel cell works.
- build models to scale.
- conduct tests by using models to collect data for analysis.
- learn about the blended wing body design.
- participate in a mousetrap car competition.

Vocabulary

concept car—a prototype of a car designed for the future

fuel cell—a device that continuously changes the chemical energy of a fuel (such as hydrogen) into electrical energy

model—a small object built to scale that represents, in detail, another often larger object; a small exact copy of something

mousetrap—a trap for catching mice

prototype—first full-size functional model to be manufactured

research—careful study and investigation for the purpose of discovering and explaining new knowledge

scale—a ratio representing the size of a picture, plan, or model of something compared to the size of the real thing

test—a trial run-through of a process or equipment to find out if it works

videoconference—a meeting in which participants are in different places, connected by audio and video links

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 2 of *The Case of the Radical Ride*, discuss the previous segment to review the problem and reaffirm what the tree house detectives have learned thus far. Download a copy of the **Problem Board** from the NASA SCI Files™ web site, select **Educators**, and click on the **Tools** section. The **Problem Board** can also be found in the **Problem-Solving Tools** section of the latest online investigation. Have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 1 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have occurred during Segment 1. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Review the list of ideas and additional questions that were created after viewing Segment 1.
5. Read the Overview for Segment 2 and have students add to their lists any questions that will help them better understand the problem.
6. Focus Questions—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.
7. "What's Up?" Questions—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. They can be printed from the web site ahead of time for students to copy into their science journals.

View Segment 2 on the Video

For optimal educational benefit, view *The Case of the Radical Ride* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about transportation, the engineering design process, identifying a problem, and finding a solution to the problem.
4. Organize the information and determine whether any of the students' questions from the previous segments were answered.
5. Decide what additional information is needed for the tree house detectives to better understand engineering design and the future of transportation. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
6. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
7. For related activities from previous programs, download the **Educator Guide** for *The Case of the "Wright" Invention*, select **Educators**, and click on **Activities/Worksheets** in the menu bar at the top. Scroll down to the 2002–2003 Season and click on *The Case of the "Wright" Invention*.

   a. In the **Educator Guide** you will find

      a. **Segment 1**—*Let's Go Inventing, Inventor's Log, Imagination Station, Bugging Out the Bugs, The Wright Brothers*

      b. **Segment 2**—*Who Invented That?; Brain Brewing Storms; What a Plan!; Criteria; Research, Research, and More Research*

      c. **Segment 3**—*Dazzling Doggie Designs, The Iterative Process, Spaghetti Anyone?, Model Making*

      d. **Segment 4**—*3, 2, 1…Crash! Testing a Model, Trademarks, Copy Cat or Copyright?, Naming Your Invention*

   b. On the web site in the **Activities/Worksheet** section, you will find

      a. *Creations of the Imagination*

      b. *Is It a Thingamajig or Thingamabob?*

      c. *Would You Buy This Invention?*

      d. *Testing the "Wright" Weather*

      e. *Testing 1, 2, 3*

8. If time did not permit you to begin the web activity at the conclusion of Segment 1, refer to number 6 under **After Viewing** on page 15 and begin the Problem-Based Learning activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, Problem-Based Learning activity:

- **Research Rack**—books, Internet sites, and research tools
- **Problem-Solving Tools**—tools and strategies to help guide the problem-solving process
- **Dr. D's Lab**—interactive activities and simulations
- **Media Zone**—interviews with experts from this segment
- **Expert's Corner**—listing of Ask-an-Expert sites and biographies of experts featured in the broadcast

Careers

auto design engineer
mechanic
model maker
test pilot

9. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the **PBL Facilitator Prompting Questions** instructional tool found by selecting **Educators** on the web site.

10. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. For more assessment ideas and tools, go to **Educators** and click on **Instructional Tools** in the menu bar.

Resources (additional resources located on web site)

Books

Balmer, Alden J.: *Doc Fizzix's Mousetrap Powered Cars and Boats*. Doc Fizzix Publishing Company, 2002, ISBN: 0965667413.

Coughlan, John: *Experimental and Concept Cars*. Capstone Press, 1994, ISBN: 1560652101.

Levy, Matthys and Panchyk, Richard: *Engineering the City*. Chicago Review Press, Inc., 2000, ISBN: 1556524196.

Rees, Chris: *Concept Cars: An A–Z Guide to the World's Most Fabulous Futuristic Cars*. Barnes and Noble Books, 2000, ISBN: 0760721688.

Sutherland, Martha: *Model Making: A Basic Guide*. W. W. Norton and Company, 1999, ISBN: 0393730425.

Taylor, Thom; Berghoff, Kathy; and Hallett, Lisa: *How To Draw Cars Like a Pro*. Motorbooks, 1996, ISBN: 0760300100.

Resources (additional resources located on web site)

Web Sites

StatPac, Inc.—Designing Surveys and Questions
A great resource for educators and other adults to learn how to design surveys and questions.
http://www.statpac.com/surveys/

NASA Langley Research Center—Blended Wing Body
Visit this site to learn all about one of the newest concepts in flight—the blended wing body (BWB). The BWB is a hybrid shape that resembles a flying wing, but it also incorporates features from conventional transport aircraft. This new shape helps increase fuel economy and creates a larger payload (cargo or passenger) area.
http://oea.larc.nasa.gov/PAIS/FS-2003-11-81-LaRC.html

National Academy of Engineering—Engineer Girl!
A web site devoted to inspiring young girls to become engineers.
http://www.engineergirl.org/nae/cwe/egmain.nsf/?OpenDatabase

PBS Kids Cyberchase—Jigsaw Puzzle Size-Up
Sure, you're great at solving jigsaw puzzles, but here are some puzzles with a twist. Some of the pieces have been changed to different sizes, and you have to get them back again. When you finish, visit "Games Central" for lots of other exciting and fun games!
http://pbskids.org/cyberchase/games/sizeandscale/sizeandscale.html

Ratio and Scaled Figures
Visit this site for an easy to understand explanation of ratio and scale for teachers and upper elementary students.
http://richardbowles.tripod.com/maths/ratio/ratio.htm

Young Inventors' Awards Program
Craftsman and the National Science Teachers Association (NSTA) challenge students in grades 2–8 to use creativity and imagination, along with science, technology, and mechanical ability, to invent or modify a tool. Awards include $250 to $10,000 in Series EE savings bonds for students and various merchandise rewards for teachers. Every student who enters receives a craftsman tool. Deadline for entry is mid-March of each year.
http://www.nsta.org/programs/craftsman.asp

How Stuff Works: Fuel Cells
Great explanation of how a fuel cell works, problems with a fuel cell, and much more.
http://science.howstuffworks.com/fuel-cell.htm

U.S. Department of Energy—Hydrogen and Fuel Cells
This web site is a great resource for learning more about hydrogen, fuel cells, future technology, and how it will all benefit society. The U.S. Department of Energy also offers a FREE CD that contains a 104-page middle school activity guide. Just call 1-877-337-3463 to request a copy.
http://www.eere.energy.gov/hydrogenandfuelcells/

The Online Fuel Cell Information Center
This web site is a great online resource for educators. Learn how a fuel cell works, types of fuels cells, applications and benefits of fuel cells, and much more. This comprehensive web site also offers photos, diagrams, books, and other reference sources.
http://www.fuelcells.org

Doc Fizzix—Mousetrap Powered Vehicles and More
This site is a great resource for mousetrap car kits, construction tips, mouse physics demonstrations, and more.
http://www.mousetrap-cars.com/mousetrap/doc_fizzix_site.htm

Discover Engineering
As you dig into this site, you will discover a wealth of information on engineering and careers. There are also games and some really "cool stuff."
http://www.discoverengineering.org/home.asp

Lemelson-MIT Program—Inventor of the Week
Each week learn about an inventor and the invention(s) that made him or her famous.
http://web.mit.edu/invent/i-main.html

The University of Sydney—Model Making and Paper Craft
This site contains dozens of links to great models that can be made from paper and paper products.
http://science.uniserve.edu.au/school/k_6/model_paper.html

Activities and Worksheets

Fueling With H_2O

Purpose

To demonstrate how a fuel cell works by splitting water into hydrogen and oxygen.

Background

Fuel cells use hydrogen and oxygen to create electricity, with only water and heat as by-products. Hydrogen is abundant, clean, and efficient, and it is available from many different resources such as natural gas and water. Hydrogen fuel cell technology offers the promise of a world in which energy is abundant, clean, reliable, and affordable.

A molecule of water has two atoms of hydrogen and one atom of oxygen. You can split a water molecule into its hydrogen and oxygen parts by passing an electrical current through the water between two electrodes (a negative cathode and positive anode). An electrode is a conductor (metal or carbon) used to make electrical contact with a part of an electrical circuit that is not metallic.

Materials

6-volt battery
tap water
aluminum foil
2 wire test leads *(insulated copper wire)*
4 double-ended alligator clips
salt
large, clear glass or plastic tub
scissors
science journal

Procedure

1. To make the electrodes, cut two pieces of aluminum foil 6 cm x 10 cm.
2. Fold each piece lengthwise (accordion style) so that each pleat is approximately 1 cm wide. Be sure to firmly press the foil together as if making a small paper fan.
3. Attach an alligator clip to each end of both lead wires.
4. Fill the clear container 3/4 full of tap water.
5. Attach one of the alligator clips from each wire to the battery.
6. Attach the other end of the wire with the alligator clip to one short end of each electrode. See diagram 1.
7. In your science journal, predict what will happen when you place both electrodes in the water.
8. Place the electrodes in the water at opposite ends from each other. Do not let the electrodes touch. Secure them in place either by bending the aluminum foil over the sides of the container or by using additional alligator clips. Label or identify each electrode as either "+" or "–" according to which battery terminal it is connected. See diagram 2.
9. Observe and record your observations.
10. In your science journal, write your prediction as to what will happen when you add salt to the water. Note: Salt is a catalyst, a substance that changes the rate of a chemical reaction but is not changed itself.
11. Add salt until the water becomes cloudy.
12. Observe the water and the electrodes for a short period of time (3–5 minutes) and record your observations. Note any differences in the water near each electrode.

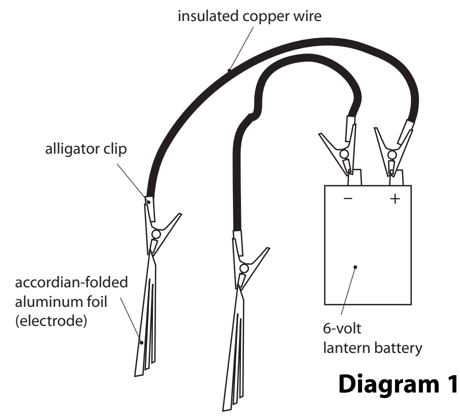


Diagram 1

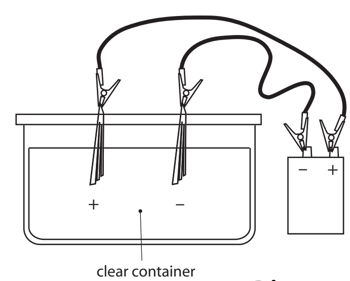


Diagram 2

Fueling With H_2O (concluded)

Conclusion

1. The electrodes in the water produced two different gases. What are they?
2. How did you know that gases were being produced?
3. Which gas did the positive electrode produce? How do you know?
4. What gas did the negative electrode produce? How do you know?
5. Why did you add salt to the water? Hint: Think about when electricity can flow through a circuit.
6. Discuss and describe ways that fuel cell technology might improve our lifestyles.

Extension

1. Collect the gases that are created by the electrodes. To collect the gases, submerge two test tubes in the water so that each is completely filled. Turn each test tube upside down. Lift the tubes slightly out of the water, making sure to keep them upside down so that no air leaks into the tube. Insert an electrode into each tube and wait for them to fill with gas. One will fill more quickly than the other. Explain why. See diagram 3.
2. Test for hydrogen by having an adult light a candle and carefully set it beside the water container. Pull the tube filled with hydrogen out of the water, keep it upside down, and hold it over the candle. See diagram 5. This procedure must be done quickly because the hydrogen will escape very fast once it is out of the water. Listen for a "puff." Move the tube away from the candle for a few seconds and repeat. This time you shouldn't hear anything. **CAUTION**: Do not try this with the oxygen.

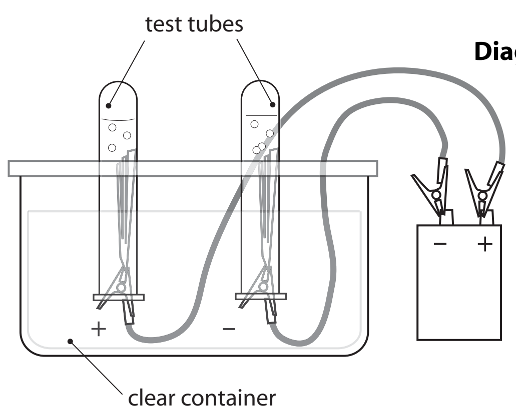


Diagram 3

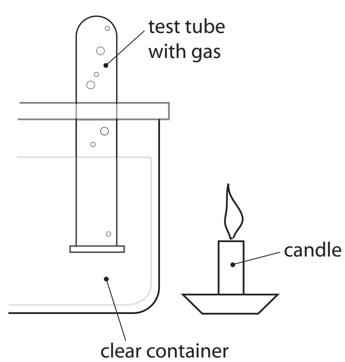


Diagram 4

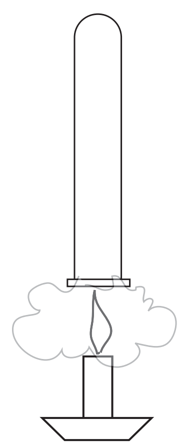


Diagram 5

Model Making

It is time to make a model of your design! Use the suggested list of ideas to help you make your model.

Before making a model, research model making. Visit the library for books on model making or conduct an Internet search.

Think about the materials that you will need to make the model. What supplies will you need? How much will they cost? Be imaginative and creative in making your model. List the supplies needed below:

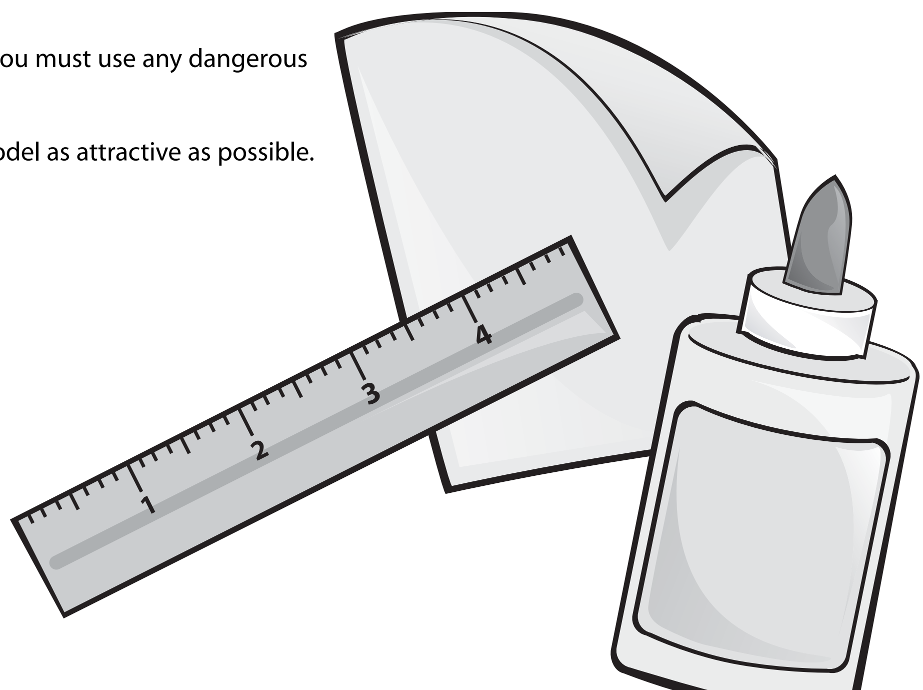
1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________

Look at your design carefully and in your Designer's Log, write in detail the steps that you will follow to build your model. Writing out the steps will help you work out problems before you start the actual building process. This step will help save you time and money as it may prevent you from having to throw out the model and start over!

Solicit help from an adult if you must use any dangerous items.

Try to make your finished model as attractive as possible.

Good luck!



Modeling With Scale

Problem To understand how to use scale to create a model

Teachers Note MatchBox® cars are usually on a scale of 1:64. Check the package of each car for more details to verify the scale. Have the students use either a standard or metric ruler to measure the cars, depending on the model of car. Most American cars are not built using metrics.

Materials

ruler
MatchBox® cars
modeling clay
science journal

Background A model is usually a smaller copy of an object such as a car or an airplane that helps us look at objects that are too large or too small to be built in actual size. When making a model, scientists use scale or ratio. A ratio is a comparison of two or more measurements. The scale gives the ratio of the model measurements to the measurements of the actual object. For example, if you had a model car that was built using the ratio 1:2 (1 to 2), the model would be one-half the size of the original car. The model looks like the actual object, only smaller. A ratio is a fraction used to compare the size of two numbers to each other. Scale models are useful in many fields, including architecture, automobile design, and airplane engineering. Many people have made a hobby of building or collecting models of a variety of objects such as cars, airplanes, ships, lighthouses, and dollhouses. Some toys are actually scale models of real or imagined objects.

Procedure

1. Use a ruler to measure the length, width, and height of your model car.
2. Use a scale of 1:64 to determine the length, width, and height of the actual car. Remember that the scale means that for every unit of the model, the real car would be 64 times that amount.
3. Calculate the dimensions in feet and inches and record them in your science journal.
4. Use the actual dimensions of a real car to create a model by first deciding upon a scale such as 40:1. Note: The larger number is now first because you decreased the size of the actual car to a smaller size. Divide the actual measurements by the number used in the scale (40).
5. Record your measurements in your science journal.
6. Use the scaled dimensions to create a clay model of the car.

Conclusion

1. Why did you multiply when increasing the size of the model to the actual size?
2. Why did you divide when decreasing the size of the actual car to a model?
3. When creating the clay model, did you need to take additional measurements other than length, width, and height?
4. List other ways that models are used.

Extension

1. Create a scale model of a model. Use the dimensions of a Matchbox® car to make a model that is larger, but not full-size.

The Blended Wing Body (BWB)

Materials

8.5- x 11-inch paper

Purpose

To demonstrate the great opportunity there is for aeronautics innovation

Teacher Note

You can find this activity on a NASA bookmark that can be printed from *http://spacelink.nasa.gov/products/Blended.Wing.Body.Bookmark/*

Background

NASA's Aerospace Research and Technology Base program is developing technologies for a new type of aircraft that will be more economical and efficient than today's airliners. This revolutionary flying wing configuration, called the BWB, has a thick, airfoil-shaped fuselage section that combines the engines, wings, and body into a single lifting surface. The BWB can carry as many as 800 passengers over 7,000 miles at an approximate cruise speed of 560 mph. Compared to today's airliners, it would reduce fuel consumption, harmful emissions, operating cost, and noise levels. NASA is developing high-payoff technologies for a new generation of safe, environmentally compatible, and highly productive aircraft. Airplanes of the future may look very different from those of today. In the activity below, be an engineer and experiment with a possible new wing type.

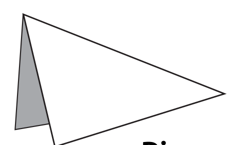


Diagram 1

Procedure

1. Fold a piece of 8.5- x 11-inch paper diagonally as shown in diagram 1.
2. Make a 1/2-inch fold along the previously folded edge. See diagram 2.
3. Make a second 1/2-inch fold. See diagram 3.
4. Curl the ends of the paper to make a ring and tuck one end into the fold of the other. See diagram 4.
5. Gently grasp the "V" between the two "crown points" with your thumb and index finger.
6. Toss the glider lightly forward. Note: The folds in the paper make the airplane's front end heavy and the back end light. Curling the ends to make a ring changes the shape of the wing and improves the wing's flight performance.

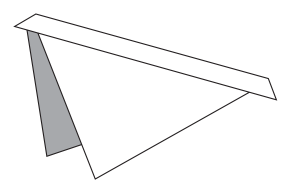


Diagram 2

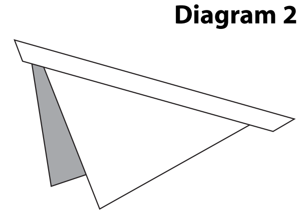


Diagram 3

Conclusion

1. How did the flight characteristics change with each ring change?

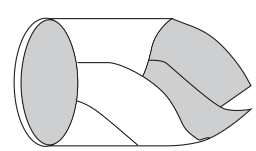


Diagram 4

Extension

1. Conduct trial tests to find the average distance your wing glider can fly.
2. Hold competitions between gliders.
3. Make modifications to the glider and conduct trial tests to compete against other modified gliders.

Mousetrap Car

Problem

To design and engineer a car solely powered by one standard-sized mousetrap that will travel the greatest distance

Materials

Design Log (p. 22)
1 standard mousetrap
string
rubber bands
material for axles (dowel rods, skewers, straws)
wheels (lids, compact disks, butter tub lids)
glue
low temperature glue gun (optional)
scissors
graph paper
meter stick
masking tape
other**

Teachers Note

- Before starting the design challenge, students should have a good understanding of simple machines, force and motion, and the design process. To learn more about these topics, check out *The Case of the Powerful Pulleys* and *The Case of the Wright Invention* on the NASA SCI Files™ web site **http://scifiles.larc.nasa.gov** Students can also conduct a web search to research other mousetrap car designs.

- Rubrics for assessment can be found on the NASA SCI Files™ web site in the **Educators** area by clicking on **Tools** in the menu bar and then choosing **Instructional Tools**.

- Check out NASA LIVE™ **http://live.larc.nasa.gov** to learn more about FREE videoconferencing programs that connect your students with NASA engineers, scientists, and specialists.

The time required varies, depending on how much of the project is assigned for homework. If done completely in class, it should take about six 45-minute class periods.

** *To be determined by teacher and/or student. Various objects such as foam material meat trays, Legos®, modified toy cars, balsa wood, washers, and other objects can be brought from home and used to build a mousetrap car. Be creative! To make the competition fair, provide multiple items in a pool of resources from which students can choose.*

Design Rules

1. All teams must use the same type of mousetrap.
2. Only the team members can construct the mousetrap car. (No help from parents or other adults!)
3. The mousetrap must be the sole source of propulsion, and it must move forward with the vehicle.
4. The cars must have a minimum of three wheels that remain on the ground at all times.
5. A mousetrap's spring may be removed only to adjust the length of the lever arm.
6. Vehicles must be self-starting and steer themselves.

Procedure

1. In your group, discuss the design challenge and brainstorm for various mousetrap car design ideas. List your ideas in the Design Log.
2. Reach a consensus about which design is the best.
3. Draw a diagram of the chosen design and be sure to label all parts.
4. Discuss the design and conduct research to answer any design questions.
5. Make a list of materials and collect the ones necessary for your design.
6. Work as a group to construct your vehicle.
7. Test your vehicle and make any necessary design changes.
8. Repeat step 7 until your vehicle is ready for its first race.

Mousetrap Car (concluded)

Test Track

1. In a large, open, flat area set up the test track by placing a 2-m strip of masking tape lengthwise along the floor to mark the "start" line.
2. Place a 20-m strip of masking tape perpendicular to one corner of the start line. See diagram 1.
3. Using a marker and a meter stick, mark the meters along the edge of the masking tape, starting with "0" at the start line and continuing to 20 m.
4. When measuring the distance the car traveled, use a meter stick to determine the final measurement in centimeters (cm).

Competition

1. Place the front end of the vehicle at the edge of the start line.
2. Engage and release your vehicle so it can propel itself down the track.
3. Use a meter stick or other straight, flat object to line up the front end of the vehicle to the masking tape measure. See diagram 2.
4. Measure and record the distance the vehicle traveled.
5. Repeat steps 1–5 for two more trials.
6. Find the average distance the vehicle traveled and enter it on the class chart.
7. The winner will be the vehicle that traveled the farthest.
8. The teacher or facilitator will determine other rules and criteria.

Conclusion

1. Were there any special features designed into your car that gave it a competitive edge?
2. Identify at least five physical principles that affect the operation of your car.
3. Describe how your design choices either maximized or minimized its effects.
4. Identify any particularly difficult steps in construction. What would you do differently next time?

Extension

1. Test the vehicles for speed and determine which is the fastest mousetrap car.
2. Identify science and math concepts used in the design process and explain how they helped you build the car.
3. Give awards for the most creative design, the lightest design, and so on.

Diagram 1

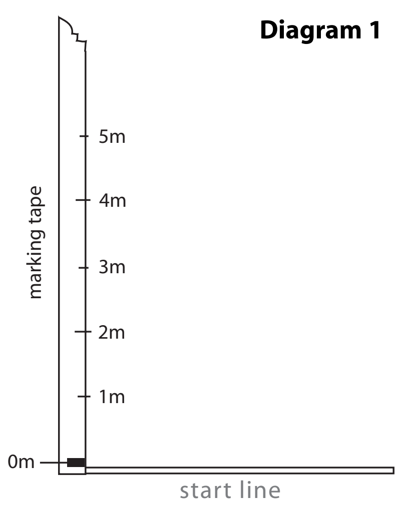
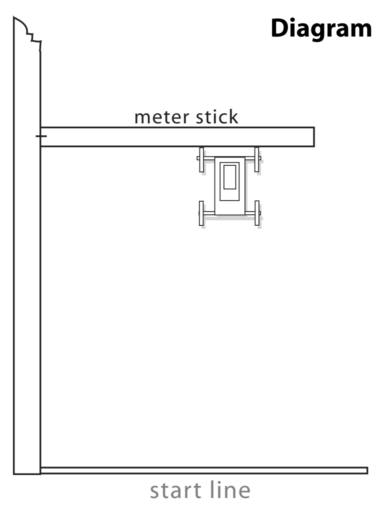


Diagram 2



Testing, 1, 2, 3...

Purpose

To test various models of airplanes and analyze the test data

This activity has been adapted from the Educational Brief for *X-Gliders: Exploring Flight Research With Experimental Gliders*. To download a complete copy with additional background information, please visit *http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/X.Gliders/.index.html*

Materials

- foam meat trays 28 cm x 23 cm
- X-glider templates (pages 44-45)
- tape
- paper clips
- binder clips
- pen
- scissors
- meter stick(s)
- masking tape
- marker
- toothpicks
- sandpaper or emery board

Teacher Note

Cut plastic foam meat trays with scissors, a razor knife, or a serrated plastic knife. Let younger students cut the parts out by using a sharp pencil or a round toothpick to punch a series of holes approximately 2 mm apart around the outside edge of the airplane part. The part can then be pushed out from the tray.

There are 12 different wing and stabilizer combinations. Each group should choose 4 combinations to test. For better test results, have multiple groups test the same combinations.

Procedure

1. Tape the glider template to the foam meat tray.
2. Cut or punch along the solid lines of each airplane part on the template.
3. Use sandpaper or an emery board to smooth out any rough edges.
4. On the fuselage, carefully cut the slot as shown on the template.
5. Choose a wing and stabilizer design and insert them into the fuselage. See diagram 1.
6. A designer must properly balance an airplane's weight for it to fly safely. Determine the proper weight and balance for your model airplane by attaching a paper clip or binder clip to the fuselage as shown in diagram 2.
7. Vary the position of the clip until the glider flies the greatest distance in a straight line. Additional clips may be needed.
8. In a large, open area (preferably inside), set up a test track by placing a strip of masking tape on the floor to create a "start" line from which to launch the planes.
9. Run another piece of masking tape perpendicular to one end of the start line.

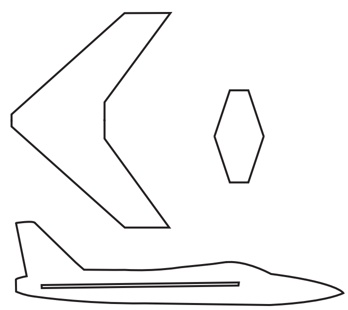


Diagram 1

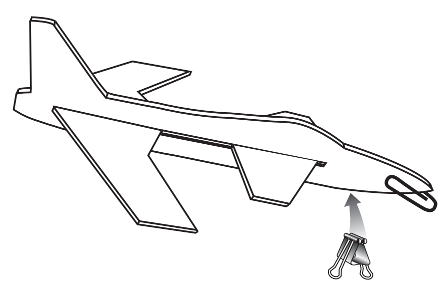


Diagram 2

Testing, 1, 2, 3...

10. Using a meter stick and a marker, place marks on the masking tape every meter for about 10 m. See diagram 3.
11. Conduct at least 3 test trials for 4 different wing and stabilizer combinations.
12. Record the test results for each in the Data Chart. Be sure to include number and placement of clips used for each trial.
13. Find the average distance that each combination flew.
14. After all test trials of all combinations have been completed, analyze your data to determine which combination flew the greatest distance.
15. Compare your results with other teams.
16. Discuss all results and determine which wing and stabilizer combination flew the best overall for the class.

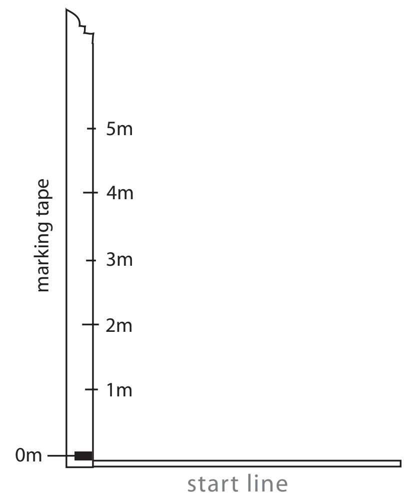
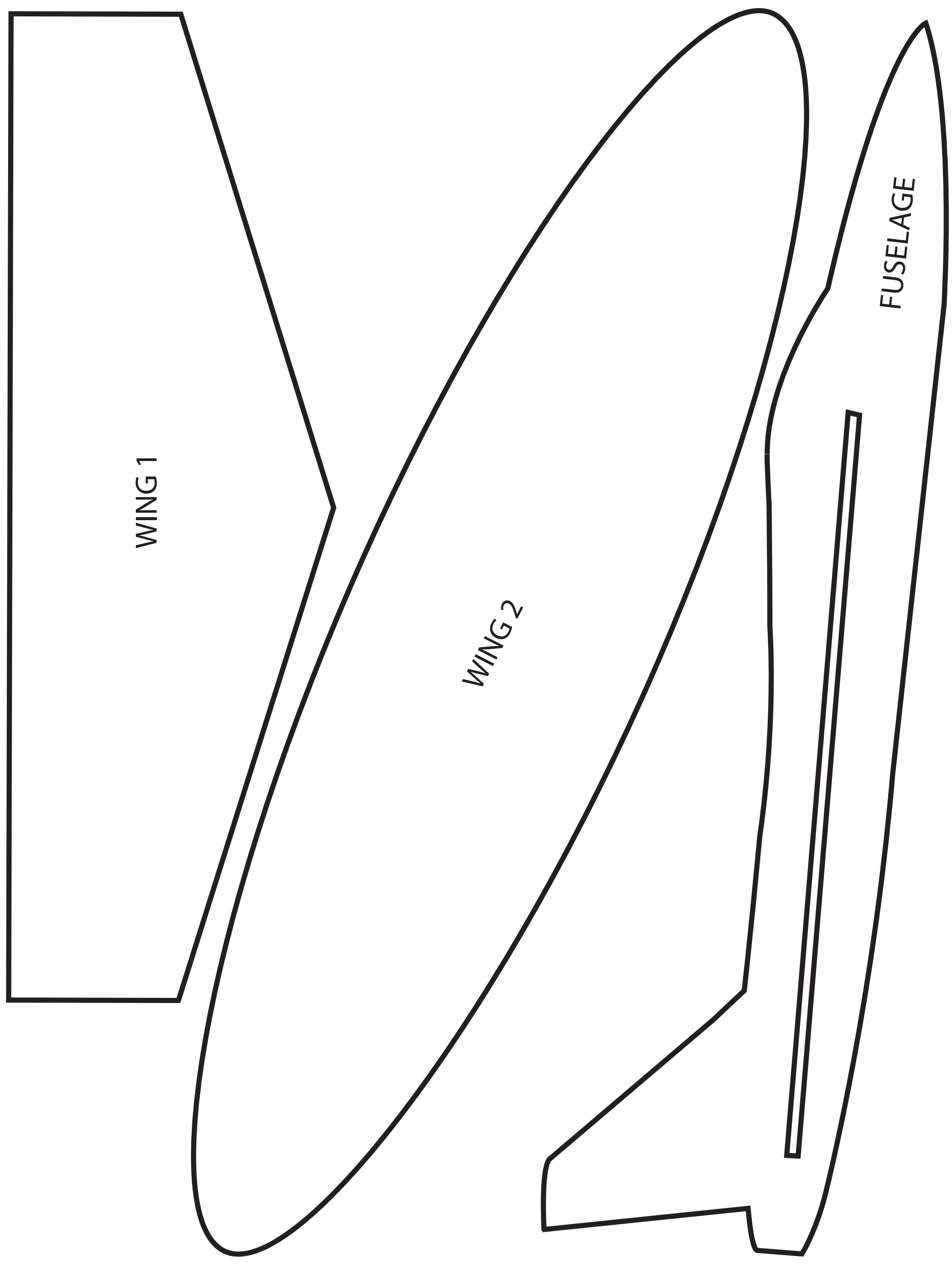


Diagram 3

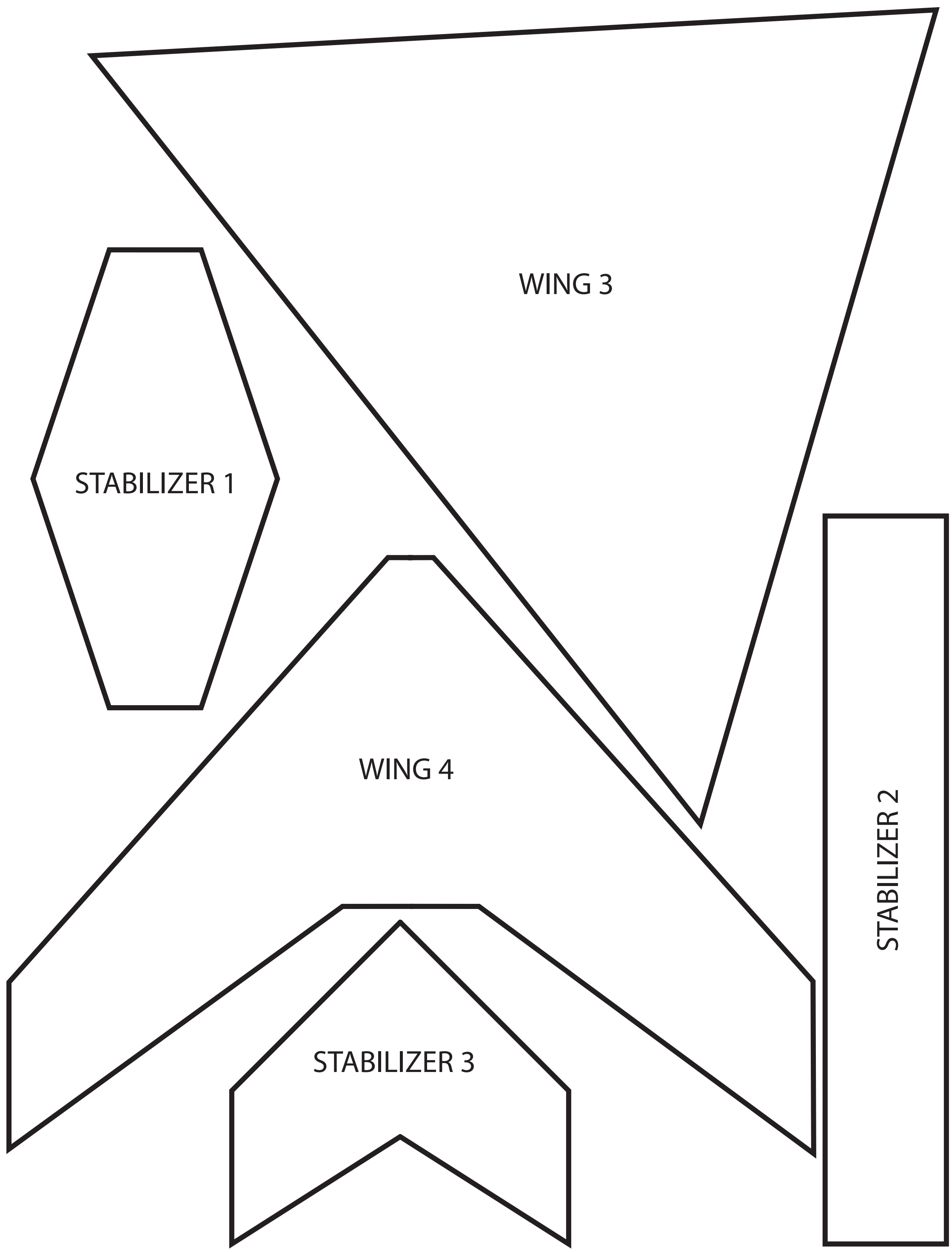
DATA CHART

Combination	**Number of Clips**	**Trial 1**	**Trial 2**	**Trial 3**	**Average Distance flown**
EXAMPLE: Wing 1 and Stabilzer 1	2 paper clips on nose and 1 binder clip 2 cm from nose	2 m	2.3 m	2.5 m	2.3 m

Testing, 1, 2, 3... X-Glider Templates



Testing, 1, 2, 3… X-Glider Templates



Answer Key

Fueling With H_2O

1. Hydrogen and oxygen.
2. Bubbles were created when the gases formed.
3. Oxygen. It was the smaller amount of gas produced. The chemical formula for water is H_2O, which means there are 2 hydrogen atoms for every oxygen atom. Atoms are about the same size and take up the same amount of space. Therefore, the electrode producing the least amount of gas has to be producing oxygen.
4. Hydrogen. It was the greatest amount of gas produced. See answer to question 3.
5. An electrical current can only flow when a circuit is closed. Tap water does not readily conduct an electric current. Dissolving salt in the water increases conductivity. The sodium and chloride atoms (ions) in salt make the water more conductive.
6. Answers will vary but might include that the consumption and burning of fossil fuels such as oil might be reduced, which will have an impact on our oil dependency and possibly reduce any global warming. Air pollutants will also be reduced.

Modeling With Scale

1. You had to multiply because the scale model is smaller than the actual size. Therefore, you had to increase the measurement of the model by the scale. To do that you have to multiply.
2. When you are decreasing from actual size to a model, you have to divide the measurements by the scale to get the size of the model.
3. Answers will vary, but depending on the type of model being created, it may have been necessary to take additional measurements to accurately make the model.
4. Answers will vary but might include toys, designing houses, showcase of new playground, dollhouse, model home, and so on.

Blended Wing Body

1. Answers will vary.

Mousetrap Car

1–4. Answers will vary.